two SMA actuator members capable of moving the panel from a second position to a first position and an elastic member applying load along a vector between two opposing ends of the panel; and

[0014] FIG. **7** depicts a schematic diagram of an exemplary bi-stable device having a rectangular deformable panel with two SMA actuator members capable of moving the panel from a second position to a first position and an elastic member applying load along a vector between two opposing ends of the panel.

DESCRIPTION OF THE EMBODIMENTS

[0015] The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

[0016] Turning now to the Figures, FIGS. **1**A and **1**B depict a schematic diagram of an exemplary reconfigurable bi-stable device **10** having a deformable panel with an SMA actuator member capable of moving the panel from a second position to a first position. In FIGS. **1**A and **1**B, a cylindrical mounting member **12** having an upper lip portion **13** is mounted on a support structure **11**. An elastically deformable panel **14**, which may be circular but may also be other shapes like rectangular, is attached to the inner circumference of the mounting member. The panel may be circular The stiffness of the panel **14** should be such that it can elastically deform between the positions shown in FIGS. **1**A and **1**B with the application of a desired amount of force. The material for the elastically deformable panel may be any material having a modulus of elasticity so that it provides the desired stiffness for the particular device design parameters (e.g., length and cross-sectional area, length-width-thickness, surface area and cross-sectional area). Suitable materials may include metals such as steel and steel alloys, aluminum, phosphor-bronze, beryllium-copper, spring (blue-temper) steels, brass, and bronze and hardened and tempered versions of the above, thermoplastics such as any of the above-described thermoplastics and/or shape memory polymers, and thermoset resins such as epoxies, cross-linked acrylics, cross-linked urethanes, and the like.

[0017] The elastically deformable panel would have a normally flat state, but is sized to have a diameter (or length and width in the case of a rectangular panel) in its normal flat state that is greater than the internal diameter of the mounting member **12** so that when it is mounted in the mounting member it is placed under a compressive force load along vectors between opposing points on the perimeter of the panel (in the horizontal plane as shown in FIG. **1**). This load causes the elastically deformable panel to deform into one of two stable states, described for sake of convenience as an upper or first stable position depicted in FIG. **1**A and a lower or second stable position depicted in FIG. **1**B. An SMA actuator member **16** is disposed between and connected to the upper face of the deformable panel **14** and lip portion **13** of the mounting member **12**. Lip portion **13** of the mounting member provides a convenient location to which to connect SMA actuator member **16** and also serves to conceal the SMA actuator member for protection and aesthetic purposes, for example, when the device of FIGS. **1**A and **1**B is used as a push button.

[0018] The SMA actuator member **16** is shown in the exemplary embodiment of FIG. **1**A in a bent memory or remembered shape. Where the FIG. **1** device is, for example, a push button, downward manual force exerted on the deformable panel **14** during the act of pushing the button causes the panel to move from its upper stable position shown in FIG. **1**A through an unstable flat configuration to its lower stable position shown in FIG. **1**B, deforming the SMA actuator member **16** to a straightened shape in the process. Heat can then be applied to the SMA actuator member, either from a heat source (not shown) or by applying an electric current through the SMA actuator member **16** to cause resistance heating. When heated, the SMA actuator member is urged to return to its remembered shape shown in FIG. **1**A, thereby exerting an upward force on the deformable panel **14**, causing it to return to the upper stable position shown in FIG. **1**A. In another exemplary embodiment, the SMA actuator **16**, instead of having a bent remembered shape, could be an SMA wire with a memorized length corresponding to the straight line distance between its mounting positions on lip portion **13** and deformable panel **14** in FIG. **1**A. When the deformable panel is moved from its position in FIG. **1**A to its position in FIG. **1**B, the SMA wire would be stretched pseudoplastically to a longer length corresponding to the straight line distance between its mounting positions on lip portion **13** and deformable panel **14** in FIG. **1**B. The deformable panel could then be returned to its position in FIG. **1**A by heating the SMA wire to cause it to return to its memorized length from FIG. **1**A. The SMA actuator **16** is depicted throughout the Figures herein with the exemplary embodiment alternating between the bent remembered shape and the deformed straight shape, but the exemplary embodiment with an SMA wire having a short remembered length and a longer deformed length could be used in any or all of the described embodiments as well.

[0019] Turning now to FIGS. **2**A and **2**B, a similar reconfigurable bi-stable device with analogous components to the device of FIGS. **1**A and **1**B is shown. However, in FIGS. **2**A and **2**B, an additional SMA actuator member **16'** is shown. The additional actuator member **16'** can augment (provide more force) and help balance the upward force applied by SMA actuator member **16** to further enhance the capability to move the deformable panel **14** from its lower or second stable position as shown in FIG. **2**B to its upper or first stable position as shown in FIG. **2**A. As an alternative to, or in conjunction with increasing the force applied to the deformable panel by adding additional SMA actuator members, the resistance to deformation of the deformable panel can be controllably lowered upon heating through the use of a composite bi-stable device having a shape memory polymer in combination with the deformable panel, as described in U.S. patent application Ser. No. _____, filed on even date herewith under attorney docket number P016484-RD-MJL, entitled "Composite Bi-Stable Device", the disclosure of which is incorporated herein by reference in its entirety.

[0020] In some exemplary embodiments, it may be desirable to use an SMA or piezoelectric member to move the deformable member of a bi-stable device in either direction between the two stable positions of the device. In FIGS. **3**A and **3**B, a reconfigurable bi-stable device similar to the device of FIGS. **2**A and **2**B is shown, but with the addition of an SMA actuator member **17** attached to and connecting the lower face of deformable panel **14** to support structure **11**. The SMA actuator member **17** is shown in FIG. **3**B in a bent memory or remembered shape. Where it is desired to move the deformable panel from the upper or first stable position to the lower or second stable position without downward manually-applied force. In the exemplary embodiment of FIGS. **3**A